Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/219
UNITED STATES
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

THERMIONIC NUCLEAR REACTORS

Robert W. Pidd (General Atomic)
George M. Grover (Los Alamos Scientific Laboratory)
Fred G. Block (Radio Corporation of America)
Herman D. Miller (General Electric - Vallecitos)
Ernest W. Salmi (Los Alamos Scientific Laboratory)
Volney C. Wilson (General Electric - Schenectady)

In the thermionic reactor concept, the heat of nuclear fission is transformed directly into electric energy by the process of thermionic emission of electric current. The system is characterized by very high power densities and operating temperatures. Required source temperatures are in the range from 1200C to 1800C. Heat rejection occurs in the range from 400C to 1000C. Applications include compact space-power units and topping units for conventional power systems. In both cases the high source and rejection temperatures indicate potential system advantages.

Two different system concepts are under study. In the out-of-pile concept, heat is extracted from a reactor heat source and is delivered to an array of thermionic converters. In the in-pile concept, the reactor fuel element essentially forms the high-temperature electrode of the thermionic converter. The in-pile design has been studied in some detail, particularly fuel-element designs and heat transmission by conventional and novel means. For the space-reactor system, the radiator, power conditioning equipment, and shielding require consideration as important contributors to system weight.

Considerable research emphasis has been placed on the development of a basic understanding of the thermionic converter. Control of the properties of the emitter and collector surface by cesium absorption has been extensively studied. Understanding of plasma dynamics is made difficult by discharge effects occurring in most ranges of efficient operation. Limitations to converter and system performance are set by high-temperature properties of materials. Screening and evaluation of a large variety of nuclear fuel and

cladding have been performed for the thermionic temperature range from 1200C to 2000C. Insulators, seals and envelope materials operable up to 1000C have been investigated.

Converter testing results for both out-of-pile and in-pile generators are summarized as a basis for establishing the present state of development of nuclear thermionics. The techniques of thermionic in-pile testing have been reviewed. Out-of-pile cell testing periods exceed several thousands of hours. In-pile testing at high performance has been accomplished for periods of several hundreds of hours, with 1000 hours of continuous testing as a current program goal.